

**Table 1. Summary of chemicals of concern and their respective concentrations for sediments in Ward Cove in 1996 and 1997**

Station	1996			1997		
	Total Ammonia (mg/kg)	Total Sulfide (mg/kg)	4-Methyl-phenol ( $\mu\text{g}/\text{kg}$ )	Total Ammonia (mg/kg)	Total Sulfide (mg/kg)	4-Methyl-phenol ( $\mu\text{g}/\text{kg}$ )
<b>Ward Cove-Subtidal</b>						
1	310	1,700	6,000			
2	220	1,200	11,000	85	4,500	15,000
3	14	5,300	5,600	80	500	6,200
4	97	6,500	2,900	150	3,700	4,500
5	67	5,400	860	57	2,300	16,000
6	360	2,200	8,300			
7	74	1,800	1,700	120	1,900	7,500
8	100	2,700	1,400			
9	82	4,500	1,400			
10	99	5,500	250 <i>U</i>			
11	50	1,500	200 <i>U</i>	34	2,300	380
12	260	2,700	620	240	1,900	8,300
13	150	4,300	390	320	2,700	1,700
14	130	2,200	1,000			
15	83	2,700	220			
16	81	16,000	250 <i>U</i>	40	12,000	1,200
17	11	27,000	250 <i>U</i>	99	50	570
18	13	150	20 <i>U</i>	13	310	26
19	44	800	250 <i>U</i>	110	5,500	730
20	84	420	470			
21	88	3,500	250 <i>U</i>			
22	21	380	200 <i>U</i>	19	560	24
23	14	1,200	49	86	3,900	170
24	34	670	250 <i>U</i>			
25	160	1,000	1,700	120	3,800	6,600
26	66	2,200	200 <i>U</i>			
27	43	4,300	200 <i>U</i>	47	4,500	470
28	34	2,400	200 <i>U</i>	34	4,400	802
31				510	11,000	17,000
32				82	13,000	2,700
33				23	1,600	980
34				120	2,300	5,100
35				120	3,300	460
37				54	2,700	4,400
38				260	6,700	8,300
39				110	2,700	1,300
40				80	3,800	1,000
41				58	48	640
42				82	2,000	5,700
43				110	9,700	1,000
44				690	2,300	9,000
45				170	4,800	2,400
47				120	3,000	1,800
48				300	3,900	1,100
<b>Ward Cove-Intertidal</b>						
50				3.2	20 <i>U</i>	10 <i>U</i>
51				11	1,000	231

**Note:** All concentrations reported on dry weight basis.

*U* - undetected at concentration listed

**Table 2. Summary of conventional CoPCs for sediments in Ward Cove and Moser Bay in 1996 and comparison with sediment quality values**

Station	TOC (percent)	Total Ammonia (mg/kg)	Total Sulfide (mg/kg)	BOD (g/kg)	COD (g/kg)
<b>Ward Cove-Subtidal</b>					
1	32 **	310 **	1,700	16 *	480
2	14	220 **	1,200	9.9	330
3	22	14	5,300	7.3	250
4	26	97	6,500	12 *	470
5	36 **	67	5,400	10	590 *
6	33 **	360 **	2,200	13 *	540
7	26	74	1,800	8.7	620 *
8	24	100	2,700	12 *	2,400 **
9	27	82	4,500	19 *	550
10	27	99	5,500	9.8	340
11	14	50	1,500	6.4	190
12	24	260 **	2,700	10	520
13	22	150 **	4,300	8.3	440
14	25	130 **	2,200	16 *	190
15	25	83	2,700	6.0	490
16	31	81	16,000	18 *	620 *
17	31	11	27,000	7.6	150
18	1.1	13	150	1.4	17
19	18	44	800	9.6	270
20	17	84	420	11	120
21	21	88	3,500	6.2	420
22	5	21	380	3.5	98
23	13	14	1,200	7.9	200
24	13	34	670	7.0	190
25	11	160 **	1,000	9.2	160
26	30	66	2,200	8.5	550
27	21	43	4,300	10	330
28	20	34	2,400	10	330
<b>Moser Bay-Subtidal</b>					
29	4	12	590	2.1	71
30	5	11	570	4.5	130
<b>WCSQV<sub>(1)</sub></b>	<b>31 <sup>a</sup></b>	<b>110 <sup>a</sup></b>	<b>NA</b>	<b>11 <sup>a</sup></b>	<b>550 <sup>a</sup></b>
<b>WCSQV<sub>(2)</sub></b>	<b>31 <sup>a</sup></b>	<b>120 <sup>a</sup></b>	<b>NA</b>	<b>37 <sup>a</sup></b>	<b>620 <sup>a</sup></b>

**Note:** All concentrations reported on dry weight basis.

- \* - concentration exceeds WCSQV<sub>(1)</sub>
- \*\* - concentration exceeds WCSQV<sub>(2)</sub>
- BOD - biochemical oxygen demand
- COD - chemical oxygen demand
- CoPC - chemical of potential concern
- NA - sediment quality values not available
- TOC - total organic carbon
- WCSQV<sub>(1)</sub> - Ward Cove sediment quality value analogous to sediment quality standard
- WCSQV<sub>(2)</sub> - Ward Cove sediment quality value analogous to minimum cleanup level

<sup>a</sup> Site-specific sediment quality value.

**Table 3. Summary of CoPCs for sediments in Ward Cove and Moser Bay in 1997 and comparison with sediment quality values**

Station	TOC (percent)	Total Ammonia (mg/kg)	Total sulfide (mg/kg)	BOD (g/kg)	COD (g/kg)	4-Methylphenol (Fg/kg)
<b>Ward Cove-Subtidal</b>						
2	33 **	85	4,500	45 **	12	15,000 **
3	30	80	500	46 **	10	6,200 **
4	25	150 **	3,700	64 **	13	4,500 **
5	38 **	57	2,300	9.2	5.6	16,000 **
7	26	120 *	1,900	8.0	10	7,500 **
11	19	34	2,300	14 *	16	380
12	21	240 **	1,900	6.4	7.8	8,300 **
13	22	320 **	2,700	12 *	7.0	1,700 *
16	28	40	12,000	13 *	16	1,200
17	28	99	50	10	10	570
18	4.0	13	310	1.6	2.2	26
19	17	110	5,500	8.5	11	730
22	4.0	19	560	3.5	6.5	24
23	9.0	86	3,900	37 *	26	170
25	13	120 *	3,800	34 *	30	6,600 **
27	20	47	4,500	34 *	12	470
28	19	34	4,400	32 *	5.6	802
31	21	510 **	11,000	11	13	17,000 **
32	23	82	13,000	9.1	7.1	2,700 **
33	5.1	23	1,600	1.7	4.5	980
34	29	120 *	2,300	10	12	5,100 **
35	30	120 *	3,300	14 *	10	460
37	31	54	2,700	7.1	8.7	4,400 **
38	34 **	260 **	6,700	65 **	15	8,300 **
39	23	110	2,700	7.7	8.3	1,300
40	23	80	3,800	7.8	11	1,000
41	22	58	48	6.4	52	640
42	24	82	2,000	6.9	11	5,700 **
43	18	110	9,700	7.4	10	1,000
44	26	690 **	2,300	13 *	15	9,000 **
45	21	170 **	4,800	9.1	12	2,400 **
47	26	120 *	3,000	7.1	7.9	1,800 **
48	25	300 **	3,900	9.2	19	1,100
<b>Moser Bay-Subtidal</b>						
29	3.6	16	240	1.7	3.5	10 U
30	5.3	18	530	3.0	4.5	15 U
<b>Ward Cove-Intertidal</b>						
50	1.3	3.2	20 U	0.7	1.3	10 U
51	5.1	11	1,000	8.7	6.2	231
WCSQV <sub>(1)</sub>	31 <sup>a</sup>	110 <sup>a</sup>	NA	11 <sup>a</sup>	550 <sup>a</sup>	1,300 <sup>a</sup>
WCSQV <sub>(2)</sub>	31 <sup>a</sup>	120 <sup>a</sup>	NA	37 <sup>a</sup>	620 <sup>a</sup>	1,700 <sup>a</sup>

**Note:** All concentrations reported on dry weight basis.

- \* - concentration exceeds WCSQV<sub>(1)</sub>
- \*\* - concentration exceeds WCSQV<sub>(2)</sub>
- BOD - biochemical oxygen demand
- COD - chemical oxygen demand
- CoPC - chemical of potential concern
- NA - sediment quality values not available
- TOC - total organic carbon
- U - undetected at concentration listed
- WCSQV<sub>(1)</sub> - Ward Cove sediment quality value analogous to sediment quality standard
- WCSQV<sub>(2)</sub> - Ward Cove sediment quality value analogous to minimum cleanup level

<sup>a</sup> Site-specific sediment quality value.

**Table 4. Summary of CoPCs for sediments in Ward Cove and Moser Bay in 1996 and comparison with sediment quality values**

Station	Metals			Organic Compounds			TCDD TEC <sup>a,b</sup> (Fg/kg organic carbon)
	Cadmium (mg/kg dry weight)	Total Mercury (mg/kg dry weight)	Zinc (mg/kg dry weight)	Phenol (Fg/kg dry weight)	4-Methyl-phenol (Fg/kg dry weight)	2,3,7,8-TCDD <sup>a</sup> (Fg/kg organic carbon)	
<b>Ward Cove-Subtidal</b>							
1	4.6	0.10	205	240	6,000 **	0.02	0.24
2	2.3	0.10 <i>U</i>	135	510 *	11,000 **	0.01 <i>U</i>	0.23
3	1.3	0.70 **	214	110	5,600 **	0.01 <i>U</i>	0.23
4	4.3	0.20	277	170	2,900 **	0.03	0.46
5	1.3	0.10 <i>U</i>	117	150	860	0.02 <i>U</i>	0.14
6	4.8	0.10	165	97	8,300 **	0.01 <i>U</i>	0.15
7	7.3 **	0.25	197	200 <i>U</i>	1,700 *	0.02 <i>U</i>	0.46
8	6.1 *	0.20	203	250 <i>U</i>	1,400 *	ND	ND
9	5.0	0.10	226	250 <i>U</i>	1,400 *	0.01 <i>U</i>	0.12
10	2.8	0.10 <i>U</i>	270	250 <i>U</i>	250 <i>U</i>	ND	ND
11	2.4	0.10 <i>U</i>	115	200 <i>U</i>	200 <i>U</i>	0.01 <i>U</i>	0.06
12	5.5 *	0.10	200	200 <i>U</i>	620	0.01	0.17
13	5.2 *	0.10	142	200 <i>U</i>	390	0.01 <i>U</i>	0.08
14	6.7 *	0.10	188	200 <i>U</i>	1,000	0.02	0.26
15	4.8	0.10	121	200 <i>U</i>	220	0.01 <i>U</i>	0.14
16	3.7	0.10 <i>U</i>	190	360	250 <i>U</i>	0.01 <i>U</i>	0.07
17	1.0	0.10 <i>U</i>	192	250 <i>U</i>	250 <i>U</i>	0.01 <i>U</i>	0.03
18	0.2	0.10 <i>U</i>	43	15	20 <i>U</i>	0.06 <i>U</i>	0.10
19	3.7	0.10	110	250 <i>U</i>	250 <i>U</i>	0.01 <i>U</i>	0.11
20	5.3 *	0.20	147	200 <i>U</i>	470	0.01 <i>U</i>	0.18
21	5.2 *	0.10	135	250 <i>U</i>	250 <i>U</i>	0.01 <i>U</i>	0.16
22	1.0	0.10 <i>U</i>	69	200 <i>U</i>	200 <i>U</i>	0.02 <i>U</i>	0.10
23	2.5	0.20	159	46	49	0.02 <i>U</i>	0.06
24	3.5	0.20	242	250 <i>U</i>	250 <i>U</i>	0.02 <i>U</i>	0.22
25	3.7	0.10	340	130	1,700 *	0.02 <i>U</i>	0.21
26	4.0	0.10	144	200 <i>U</i>	200 <i>U</i>	0.01 <i>U</i>	0.14
27	4.7	0.10	133	200 <i>U</i>	200 <i>U</i>	0.03 <i>U</i>	0.05
28	2.6	0.10 <i>U</i>	171	200 <i>U</i>	200 <i>U</i>	ND	ND
<b>Moser Bay-Subtidal</b>							
29	0.33	0.10 <i>U</i>	78	20 <i>U</i>	20 <i>U</i>	ND	ND
30	1.4	0.10 <i>U</i>	70	20 <i>U</i>	20 <i>U</i>	0.02 <i>U</i>	0.03
SQS/WCSQV <sub>(1)</sub>	5.1 <sup>c</sup>	0.41 <sup>c</sup>	410 <sup>c</sup>	420 <sup>c</sup>	1,300 <sup>d</sup>	NA	NA
MCUL/WCSQV <sub>(2)</sub>	6.7 <sup>c</sup>	0.58 <sup>c</sup>	960 <sup>c</sup>	1,200 <sup>c</sup>	1,700 <sup>d</sup>	NA	NA

**Note:** \* - concentration exceeds sediment quality standard  
 \*\* - concentration exceeds minimum cleanup level  
 CoPC - chemical of potential concern  
 NA - sediment quality values not available  
 ND - no data  
 TCDD - tetrachlorodibenzo-*p*-dioxin  
 TEC - toxic equivalent concentration  
 TOC - total organic carbon  
*U* - undetected at concentration listed  
 WCSQV<sub>(1)</sub> - Ward Cove sediment quality value analogous to sediment quality standard  
 WCSQV<sub>(2)</sub> - Ward Cove sediment quality value analogous to minimum cleanup level

<sup>a</sup> Concentrations are normalized to station-specific TOC concentrations, except that a TOC concentration of 10 percent was used for all station-specific values that were \$ 10 percent.

<sup>b</sup> Detection limits are included in the sum at half their value.

<sup>c</sup> Washington State sediment management standard.

<sup>d</sup> Site-specific sediment quality value.

**Table 5. Identification of CoCs for human health based on maximum estimated or measured seafood concentrations**

Chemical	Maximum Sediment Concentration <sup>a</sup> (mg/kg dw)	Maximum Seafood Concentration <sup>b</sup> (mg/kg ww)	Oral CSF (mg/kg-day) <sup>-1</sup>	Oral RfD (mg/kg-day)	Background Tissue Concentration (mg/kg ww)	Risk-Based Tissue Concentration <sup>d</sup> (mg/kg ww)	Identified as CoC for Human Health
<b>Metals and Organometallic Compounds</b>							
Arsenic <sup>e</sup>	39	0.12	1.5	0.0003	0.15 <sup>e</sup>	0.30	No
Cadmium	7.3	3.7	ND	0.001	NA	19	No
Total mercury (sediments; methylmercury in tissues)	0.7	0.07	ND	0.0001	NA <sup>f</sup>	1.9	No
Total mercury (measured)		0.026			NA <sup>f</sup>	1.9	No
Zinc	396	495	ND	0.3	NA	5,800	No
<b>Organic Compounds</b>							
Phenol	0.91	0.47	ND	0.6	NA	12,000	No
4-Methylphenol	17	8.8	ND	0.005	NA	96	No
PCDD/F (TEC)	$4.6 \times 10^{-5}$	$3.9 \times 10^{-5}$	150,000	ND	$0.2 \times 10^{-6}$ <sup>g</sup>	$3.0 \times 10^{-6}$	Yes <sup>h</sup>
PCDD/F (TEC) (measured tissue data)		$0.78 \times 10^{-6}$ <sup>i</sup>			$0.2 \times 10^{-6}$ <sup>g</sup>	$3.0 \times 10^{-6}$	No
<b>PAHs</b>							
Carcinogenic PAH (RPC)	0.41	0.072	7.3	ND	NA	0.42	No
Fluoranthene	2.2	0.39	ND	0.04	NA	5,300	No
Pyrene	1.8	0.32	ND	0.03	NA	4,000	No
Acenaphthene	0.50	0.088	ND	0.06	NA	8,000	No
Anthracene	0.26	0.046	ND	0.3	NA	40,000	No
Fluorene	0.47	0.083	ND	0.04	NA	5,300	No
<b>Note:</b>							
	- values updated with 1997 data	PAH	- polycyclic aromatic hydrocarbon				
	- biota-sediment accumulation factor	PCDD/F	- polychlorinated dibenz-p-dioxin and polychlorinated dibenzofuran				
	- chemical of concern	RfD	- reference dose				
CoC	- carcinogenic slope factor	RPC	- relative potency concentration for carcinogenic PAHs				
CSF	- dry weight	TEC	- toxic equivalent concentration based on data for 2,3,7,8-tetrachlorodibenzo-p-dioxin				
dw	- not available	ww	- wet weight				
EPA	- U.S. Environmental Protection Agency						
NA	- not determined by EPA or not considered to be a carcinogen						

<sup>a</sup> Concentrations are maximum sediment concentrations, except for phenol, PAHs (RPCs), anthracene, and zinc, which exclude higher sediment concentrations identified at locations remote from the site (i.e., Station 23 at the state airplane ramp and Stations 24 and 25 at the cannery). For undetected concentrations, one-half the detection limit was used in the RPC and TEC calculations.

<sup>b</sup> Concentrations estimated using BSAFs except data for PCDD/F (TECs) and mercury as indicated. Concentrations for all substances except PAHs were estimates for fish tissues. Higher estimated concentrations of some chemicals in shellfish would be offset by lower (or absent) site-related intake. PAHs were evaluated based on highest estimated shellfish concentrations because although PAHs may be taken up into fish, they also are rapidly metabolized and, thus, do not readily bioaccumulate in fishes.

**Table 5. (cont.)**

<sup>c</sup> Toxicity values obtained from either the EPA Health Effects Assessment Summary Tables (May 1997) or EPA Integrated Risk Information System (June 1998).

<sup>d</sup> Risk-based concentrations were derived on the basis of consumption of fish and shellfish combined, for all substances except PAHs. Risk-based concentrations for PAHs were based on consumption of shellfish only because PAHs are assumed not to bioaccumulate in fish.

<sup>e</sup> Estimated total arsenic concentration adjusted assuming 10 percent inorganic arsenic (ICF Kaiser 1996). Background concentration was a measured inorganic arsenic concentration reported in Eisler (1994).

<sup>f</sup> Although a maximum background concentration of 1.8 mg/kg was identified in U.S. EPA (1992), this value was the highest concentration in the data set, which included seafood from industrial areas, and therefore was not included here.

<sup>g</sup> Background concentration from a study near Sitka, Alaska, in Delta Toxicology (1995).

<sup>h</sup> See Section 7.1.4 of this ROD.

<sup>i</sup> Maximum TEC in mussels (whole body) in EVS (1996). TECs derived using one-half the detection limit for undetected congeners.

**Table 6. Summary of sediment toxicity results for Ward Cove and Moser Bay in 1996 and comparison with sediment quality values**

Station	<i>Rhepoxynius abronius</i> Survival (percent)	<i>Leptocheirus plumulosus</i> Survival (percent)	<i>Neanthes</i> sp. Individual Growth Rate (mg/day)	<i>Dendraster excentricus</i> Normal Survival (percent)	<i>Dendraster excentricus</i> Embryo Normality (percent)
<b>Ward Cove</b>					
1	50(32.2)**	93(4.5)	0.59(0.12)	51(19.0)**	85(11.1)*
2	7(10.9)**	94(4.2)	0.64(0.08)	55(10.1)**	93(5.5)
3	90(7.9)	93(5.7)	0.54(0.06)	51(25.6)**	88(11.9)*
4	64(15.2)*	93(6.7)	0.62(0.11)	56(19.5)**	87(9.6)*
5	25(19.0)**	98(2.7)	0.57(0.04)	48(28.1)**	74(26.6)*
6	5(8.7)**	88(6.7)	0.62(0.11)	54(21.4)**	92(7.1)
7	90(7.9)	99(2.2)	0.61(0.08)	61(13.5)*	86(12.4)*
8	43(22.8)**	89(13.9)	0.68(0.16)	58(13.9)**	89(11.1)*
9	54(17.8)**	92(7.6)	0.63(0.10)	43(23.0)**	92(6.8) <sup>a</sup>
10	75(14.6)	96(4.2)	0.67(0.16)	50(13.2)**	97(1.7)
11	94(8.2)	97(4.5)	0.54(0.11)	47(23.7)**	95(3.4) <sup>a</sup>
12	3(2.7)**	93(10.9)	0.63(0.07)	46(18.8)**	92(2.0)
13	36(10.8)**	95(6.1)	0.56(0.19)	52(14.6)**	96(3.2)
14	60(20.9)**	98(4.5)	0.70(0.14)	64(26.0)*	93(6.6)
15	67(13.5)*	94(6.5)	0.66(0.08)	67(8.9)*	97(1.8)
16	30(15.4)**	98(2.7)	0.68(0.11)	52(17.2)**	97(1.8)
17	88(11.5)	94(6.5)	0.51(0.10)	54(30.4)**	95(3.8) <sup>a</sup>
18	95(5.0)	96(4.2)	0.55(0.07)	58(13.4)**	94(4.6)
19	48(18.9)**	100(--)	0.65(0.06)	79(15.0)	94(5.8)
20	67(16.4)*	97(4.5)	0.59(0.09)	72(18.2)	96(2.5)
21	82(16.0)	96(4.2)	0.63(0.07)	80(9.3)	98(1.2)
22	84(11.9)	92(12.6)	0.57(0.10)	80(13.3)	94(7.6)
23	94(6.5)	94(4.2)	0.64(0.10)	59(18.9)*	95(5.3)
24	89(8.2)	96(6.5)	0.57(0.07)	71(16.4)*	89(12.5)
25	3(4.5)**	96(5.5)	0.74(0.09)	58(24.2)**	94(5.8) <sup>a</sup>
26	96(4.2)	93(4.5)	0.58(0.10)	75(9.2)	93(4.4)
27	85(6.1)	98(2.7)	0.65(0.10)	72(23.2)	95(3.2) <sup>a</sup>
28	69(24.9)*	96(5.5)	0.63(0.10)	67(8.6)*	94(2.1)
<b>Moser Bay</b>					
29	91(4.2)	97(2.7)	0.48(0.09)	83(17.6)	97(2.7)
30	93(6.7)	99(2.2)	0.72(0.12)	86(8.3)	97(2.8)

**Note:** Mean values are presented, with standard deviations in parentheses.

- \* - toxicity response is less than sediment quality standard (values provided in Section 7.2.1) or, for *Dendraster excentricus* normality, response is significantly less ( $P \leq 0.05$ ) than the pooled results for Moser Bay
- \*\* - toxicity response is less than minimum cleanup level (values provided in Section 7.2.1)

<sup>a</sup> Results are calculated from four replicate samples based on an outlier analysis discussed in the text.

**Table 7. Summary of sediment toxicity results for Ward Cove and Moser Bay in 1997 and comparison with sediment quality values**

Station	<i>Rhepoxynius abronius</i> Survival (percent)	<i>Dendraster excentricus</i> Normal Survival (percent)	<i>Dendraster excentricus</i> Embryo Normality (percent)
<b>Ward Cove</b>			
2	9(17.5)**	43(20.6)**	91(6.9)
3	65(10.8)** <sup>a</sup>	53(22.6)*	96(0.8)
4	38(28.4)**	56(22.0)*	93(4.9)
5	39(22.5)**	53(12.5)*	95(3.3)
7	58(15.7)**	59(15.2)*	96(3.8)
11	83(7.6)	55(12.8)*	96(4.0)
12	14(11.9)**	43(14.4)**	94(5.6)
13	15(22.6)**	48(5.4)**	97(1.9)
16	89(4.2)	32(21.5)**	91(9.5)
17	43(39.9)**	57(16.1)*	94(4.0)
18	90(7.1)	50(23.1)**	97(2.4) <sup>a</sup>
19	59(12.9)**	61(13.5)*	96(1.9)
22	84(13.4)	78(14.0)	99(1.1)
23	79(18.8)	63(22.6)	94(4.7)
25	10(14.1)**	56(17.0)*	93(2.4)
27	75(17.3) <sup>a</sup>	38(18.7)**	95(3.2) <sup>a</sup>
28	73(16.6)* <sup>a</sup>	58(14.8)*	94(6.9)
31	3(4.5)**	28(12.8)**	95(4.5)
32	28(32.5)**	54(15.2)*	98(2.4)
33	77(11.0)	28(11.9)**	95(7.9)
34	39(10.3)** <sup>a</sup>	50(9.6)**	94(5.2)
35	75(17.0)	44(9.5)**	97(2.5)
37	65(15.4)**	68(17.0)	98(2.5)
38	0(0)**	50(27.7)**	90(9.5)
39	41(11.1)** <sup>a</sup>	68(14.1)	98(1.7)
40	75(5.8) <sup>a</sup>	76(14.9)	97(4.0)
41	90(6.1)	41(19.9)**	97(3.7)
42	68(16.8)*	57(9.0)*	97(1.8)
43	72(15.3)*	59(6.8)*	97(4.3)
44	1(2.2)**	52(13.6)*	96(1.7)
45	54(37.0)**	48(12.5)**	92(7.2)
47	73(16.1)*	49(10.0)**	97(3.5)
48	5(7.1)**	56(6.1)*	97(2.6)
<b>Moser Bay</b>			
29	96(2.2)	74(11.4)	97(2.1)
30	96(4.2)	73(16.9)	98(1.1)

**Note:** Mean values are presented, with standard deviations in parentheses.

- \* - toxicity response is less than sediment quality standard (values provided in Section 7.2.1) or, for *Dendraster excentricus* normality, response is significantly less ( $P \leq 0.05$ ) than the pooled results for Moser Bay
- \*\* - toxicity response is less than minimum cleanup level (values provided in Section 7.2.1)

<sup>a</sup> Results are calculated from four replicate samples based on an outlier analysis discussed in the text.

**Table 8. Summary results of food-web assessment for avian and mammalian receptors in Ward Cove based on maximum and mean sediment concentrations of CoPCs**

Compound	Maximum Sediment Concentration (mg/kg)	Hazard Quotient Based on Maximum Concentration					Mean Sediment Concentration (mg/kg)	Hazard Quotient Based on Mean Concentration			
		Harbor Seal	River Otter	Marbled Murrelet	Pelagic Cormorant	Harbor Seal		River Otter	Marbled Murrelet	Pelagic Cormorant	
Arsenic	39	0.009	0.13	0.0012	$6.8 \times 10^{-4}$	22	0.005	0.071	$6.5 \times 10^{-4}$	$3.9 \times 10^{-4}$	
Cadmium	7.3	0.04	0.31	1.07	0.11	3.5	0.02	0.15	0.52	0.055	
Mercury	0.7	0.009	0.15	0.11	0.048	0.1	0.001	0.021	0.016	0.007	
Zinc	396	0.011	0.14	0.16	0.11	190	0.005	0.068	0.078	0.053	
PCDDs/Fs	$4.6 \times 10^{-5}$	0.17	1.96	0.12	0.077	$1.7 \times 10^{-5}$	0.06	0.72	0.043	0.028	
PAHs	0.41	$1.9 \times 10^{-5}$	$5.1 \times 10^{-4}$	ND	ND	0.16	$7.6 \times 10^{-6}$	$2.0 \times 10^{-4}$	ND	ND	

**Note:** CoPC - chemical of potential concern  
 ND - not determined  
 PAH - polycyclic aromatic hydrocarbon  
 PCDD/F - polychlorinated dibenzo-p-dioxin and polychlorinated dibenzofuran

**Table 9. Environmental studies in Ward Cove**

Date	Summary of study	Reference
1951–1952	Water column, plankton, and benthic macroinvertebrate data were collected	AWPCB (1953)
1955–1957	Impacts to benthic macroinvertebrates and fish were observed	AWPCB (1957)
1965	Low dissolved oxygen was found in surface and bottom water	FWPCA (1965)
1968–1969	Impacts to benthic macroinvertebrates and blue mussels were observed	FWQA (1970)
1974	Improvements in water quality and benthic macroinvertebrates were observed; sediment chemical concentrations were measured for the first time	U.S. EPA (1975)
1988	Sediment toxicity was found to be associated with sulfides and oxygen demand, but not with metals	Jones & Stokes and Kinnetic (1989)
1992	Sediment toxicity was observed, and the benthic macroinvertebrate assemblage was considered characteristic of areas affected by organic enrichment	EVS (1992)
1994–1995	Spatial distributions of sediment chemicals, organic material, and sediment toxicity were related to the KPC mill	ENSR (1995)
1996–1997	Sediment CoPCs, toxicity, and physical characteristics were evaluated to support remedy selection	Exponent (1999)

**Note:** CoPC - chemical of potential concern  
KPC - Ketchikan Pulp Company

**Table 10. Summary of surface sediment data collected in Ward Cove and Moser Bay in 1996 and 1997**

Analyte	Concentration Range	Median	Number of Detected Values	Number of Samples	Frequency of Detection (percent)	Station with Maximum Concentration n	Year in Which Maximum Value Was Detected	
							1996	1997
<b>Conventional Analytes</b>								
Acid-volatile sulfide (mg/kg)	240 – 17,000	2,450	28	28	100	16		X
Total ammonia (mg/kg)	3.2 – 690	83	72	72	100	44	X	
Biochemical oxygen demand 5-day test (g/kg)	0.72 – 65	9.2	72	72	100	38		X
Chemical oxygen demand (g/kg)	1.3 – 2,400	17	72	72	100	8	X	
Total sulfide (mg/kg)	20 U – 27,000	2,500	71	72	99	17	X	
Total organic carbon (percent)	1.1 – 41	23	72	72	100	2	X	
Gravel (percent) <sup>a</sup>	0 U – 61	2.0	71	72	99	50		X
Sand (percent)								
1.0–2.0 mm	0.27 – 20	2.7	72	72	100	18	X	
0.50–1.0 mm	0.53 – 20	5.3	72	72	100	33		X
0.25–0.50 mm	0.8 – 17	9.0	72	72	100	33		X
0.125–0.25 mm	0.79 – 16	10	72	72	100	16	X	
0.062–0.125 mm	1.9 – 35	9.5	72	72	100	29		X
Silt (percent)	4.5 – 78	37	72	72	100	30		X
Clay (percent)	1.5 – 34	21	72	72	100	44		X
Total solids (percent of wet weight)	12 – 80	19	72	72	100	50		X
Extractable organic halides (mg/kg)	10 U – 79	44	4	29	14	25		X
<b>Metals</b>								
Arsenic (mg/kg)	2.7 – 39	21	31	31	100	7	X	
Cadmium (mg/kg)	0.14 – 7.3	3.5	49	49	100	7	X	
Methylmercury (Fg/kg)	0.22 – 14.3	0.90	28	28	100	23		X
Total mercury (mg/kg)	0.1 U – 0.7	0.20	20	49	41	3	X	
Zinc (mg/kg)	39 – 530	159	49	49	100	25		X
<b>Semivolatile Organic Compounds (Fg/kg)</b>								
Low molecular weight PAHs								
Naphthalene	1 – 440	50	26	32	81	3	X	
2-Methylnaphthalene	10 U – 280	53	25	32	78	3	X	
Acenaphthylene	10 U – 110	20	7	32	22	23		X
Acenaphthene	10 U – 500	40	19	32	59	3		X
Fluorene	10 U – 470	46	25	32	78	3		X
Phenanthrene	6 – 1,100	230	30	32	94	3		X
Anthracene	3 – 380	57	27	32	84	25		X
Total	10 U – 2,800	470	32	32	100	3		X
High molecular weight PAHs								
Fluoranthene	10 U – 2,200	390	30	32	94	4		X
Pyrene	8 – 1,800	270	30	32	94	4		X

**Table 10. (cont.)**

Analyte	Concentration Range	Median	Number of Detected Values	Number of Samples	Frequency of Detection (percent)	Station with Maximum Concentration	Year in Which Maximum Value Was Detected	
							1996	1997
Benz[a]anthracene	3 – 990	120	29	32	91	25	X	
Chrysene	4 – 1,300	130	30	32	94	25	X	
Benzo[b]fluoranthene	3 – 740	100	28	32	88	25		X
Benzo[k]fluoranthene	10 U – 530	52	26	32	81	25		X
Benzo[a]pyrene	10 U – 750	63	27	32	84	25		X
Indeno[1,2,3-cd]pyrene	1 – 520	37	25	32	78	25		X
Dibenz[a,h]anthracene	6 – 73 <sup>b</sup>	20	7	32	22	25		X
Benzo[ghi]perylene	1 – 290	32	24	32	75	25		X
Total	10 U – 8,100	1,300	30	32	94	25		X
Sum of carcinogenic PAH compounds	10 U – 4,900	540	30	32	94	25		X
Sum of carcinogenic PAH, RPC <sup>c</sup>	11 – 1,100	140	30	32	94	25		X
Sum of carcinogenic PAH, RPC <sup>d</sup>	0 U – 1,100	96	30	32	94	25		X
Phenols and miscellaneous compounds								
Phenol	10 U – 990	200	28	51	55	25		X
4-Methylphenol <sup>e</sup>	10 U – 17,000	990	55	72	76	31		X
Benzoic acid	100 U – 1,600	500	16	32	50	4	X	
Dibenzofuran <sup>f</sup>	10 U – 180	20	8	19	42	4		X
<b>Pulp Mill Compounds (mg/kg)<sup>g</sup></b>								
Individual chlorinated phenols	0.8 U – 2.3 U	1.8 U	0	6	0	--		
Individual chlorinated guaiacols	0.8 U – 2.3 U	1.8 U	0	6	0	--		
Individual chlorinated catechols	0.8 U – 2.3 U	1.8 U	0	6	0	--		
Individual chlorinated vanillins	0.8 U – 2.3 U	1.8 U	0	6	0	--		
Individual chlorinated syringaldehydes	0.8 U – 2.3 U	1.8 U	0	6	0	--		
Trichlorosyringol	0.8 U – 2.3 U	1.8 U	0	6	0	--		
Abietic acid	18 – 150	55	6	6	100	7	X	
Dehydroabietic acid	12 – 150	36	6	6	100	7	X	
12-Chlorodehydroabietic acid	2.9 – 22	5.0	5	6	83	7	X	
14-Chlorodehydroabietic acid	1.5 U – 23	1.8	2	6	33	7	X	
Dichlorodehydroabietic acid	1.5 U – 14	2.0	3	6	50	7	X	
9,10-Dichlorostearic acid	1.5 U – 7.2 U	1.8 U	0	6	0	--		
Pimaric acid	1.5 U – 7.2 U	1.8 U	0	6	0	--		
Isopimaric acid	4.3 – 22	6.9	5	6	83	7	X	
Linoleic acid	1.5 U – 7.2 U	1.8 U	0	6	0	--		
Oleic/linolenic acids	7.2 U – 79	14	5	6	83	7	X	
<b>Dioxins and Furans (ng/kg)</b>								
2,3,7,8-Tetrachlorodibenzodioxin	0.65 U – 2.6 <sup>b</sup>	1.3	12	42	29	4	X	
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	0.66 U – 12	3.6	25	41	61	4		X
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	0.72 U – 11 <sup>b</sup>	4.4	13	42	31	4	X	X
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	0.72 U – 44	14	35	42	83	4		X
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	0.73 U – 30	8.7	31	42	74	4		X

**Table 10. (cont.)**

Analyte	Concentration Range	Median	Number of Detected Values	Number of Samples	Frequency of Detection (percent)	Station with Maximum Concentration	Year in Which Maximum Value Was Detected	
							1996	1997
1,2,3,4,6,7,8-Heptachlorodibenzo- <i>p</i> -dioxin	2 <i>U</i> – 920	290	38	42	90	4	X	
Octachlorodibenzo- <i>p</i> -dioxin	11 – 6,300	2,100	41	42	98	4		X
Total tetrachlorodibenzo- <i>p</i> -dioxins	0.66 <i>U</i> – 290	66	37	42	88	4	X	
Total pentachlorodibenzo- <i>p</i> -dioxins	0.66 <i>U</i> – 160	37	35	42	83	4		X
Total hexachlorodibenzo- <i>p</i> -dioxins	0.86 <i>U</i> – 390	120	37	42	88	4	X	
Total heptachlorodibenzo- <i>p</i> -dioxins	4.3 – 3,100	800	42	42	100	4	X	
2,3,7,8-Tetrachlorodibenzofuran	0.58 <i>U</i> – 36	9.1	9	42	21	7	X	
1,2,3,7,8-Pentachlorodibenzofuran	0.55 <i>U</i> – 9.7	3.0	21	42	50	4	X	
2,3,4,7,8-Pentachlorodibenzofuran	0.58 <i>U</i> – 20	3.7	25	42	60	7	X	
1,2,3,4,7,8-Hexachlorodibenzofuran	0.66 <i>U</i> – 85	5.7	8	42	19	7	X	
1,2,3,6,7,8-Hexachlorodibenzofuran	0.61 <i>U</i> – 39	4.0	24	42	57	7	X	
1,2,3,7,8,9-Hexachlorodibenzofuran	1.0 <i>U</i> – 4.5 <i>U</i>	2.1	0	42	0	--		
2,3,4,6,7,8-Hexachlorodibenzofuran	0.73 <i>U</i> – 30	4.0	17	42	40	7	X	
1,2,3,4,6,7,8-Heptachlorodibenzofuran	0.78 <i>U</i> – 310	48	39	42	93	24	X	
1,2,3,4,7,8,9-Heptachlorodibenzofuran	0.98 <i>U</i> – 27	3.6	11	42	26	7	X	
Octachlorodibenzofuran	2.6 <i>U</i> – 390	145	38	42	90	4		X
Total tetrachlorodibenzofurans	0.58 <i>U</i> – 230	52	36	42	86	4		X
Total pentachlorodibenzofurans	0.6 <i>U</i> – 170	35	34	42	81	7	X	
Total hexachlorodibenzofurans	0.86 <i>U</i> – 370	69	36	42	86	7	X	
Total heptachlorodibenzofurans	0.87 <i>U</i> – 640	155	39	42	93	24	X	
Dioxin and furan toxic equivalent concentration <sup>c</sup>	1.1 – 46	15	42	42	100	7	X	
Dioxin and furan toxic equivalent concentration <sup>d</sup>	0 <i>U</i> – 45	12	42	42	100	7	X	

**Note:** Results are presented on a dry weight basis unless noted otherwise.

Concentrations for conventional analytes and organic compounds are rounded to two significant figures. Concentrations for metals are rounded to three significant figures if over 10 and two significant figures if less than 10.

Field replicates were treated as unique data points and the results were not averaged.

Medians were calculated using the detection limits for those congeners that were undetected.

-- - not applicable; the analyte was not detected at any station

PAH - polycyclic aromatic hydrocarbon

RPC - relative potency concentration

*U* - undetected at concentration listed

<sup>a</sup> When grain-size distribution is determined by the analytical laboratory, the term "gravel" is a designation for a specific size fraction in the sediment. This verbiage does not mean that the sediment is gravel. In some shallower parts of the Cove, the "gravel" size fraction could consist of wood debris and probably includes organic material.

<sup>b</sup> At least one detection limit exceeded the concentration of the indicated maximum detected value.

<sup>c</sup> Detection limits are included in the sum at half their value.

<sup>d</sup> Detection limits are excluded from the sum.

**Table 10. (cont.)**

<sup>e</sup> 3- and 4-Methylphenol results were quantified as 4-methylphenol.

<sup>f</sup> Dibenzofuran was analyzed only in 1997.

<sup>g</sup> Pulp mill compounds were analyzed only in 1996.

**Table 11. Summary of subsurface sediment data collected in Ward Cove in 1997 (excluding native sediments)**

Analyte	Concentration Range	Median	Number of Detected Values	Number of Samples	Frequency of Detection (percent)	Station with Maximum Concentration	Interval of Maximum (in.)	
							Upper Depth	Lower Depth
<b>Conventional Analytes</b>								
Total ammonia (mg/kg)	1.6 – 4,200	330	33	33	100	6	79	105
Biochemical oxygen demand 5-day test (g/kg)	3.0 – 120	7.5	33	33	100	6	0	39
Chemical oxygen demand (g/kg)	1.3 – 140	7.8	33	33	100	6	0	39
Total sulfide (mg/kg)	290 – 55,000	2,700	32	32	100	16	79	91
Total organic carbon (percent)	10 – 40	31	33	33	100	1	39	79
Gravel (percent) <sup>a</sup>	0.5 – 61	7.4	33	33	100	5	39	70
Sand (percent)								
1.0–2.0 mm	1.3 – 13	5.4	33	33	100	2	39	79
0.50–1.0 mm	1.3 – 33	6.4	33	33	100	9	39	79
0.25–0.50 mm	2.7 – 37	9.5	33	33	100	9	39	79
0.125–0.25 mm	1.7 – 19	7.9	33	33	100	36	0	22
0.062–0.125 mm	1.2 – 24	7.6	33	33	100	36	0	22
Silt (percent)	4.8 – 61	26	33	33	100	7	0	39
Clay (percent)	8.9 – 37	20	33	33	100	6	0	39
Total solids (percent of wet weight)	11 – 30	19	33	33	100	36	0	22
<b>Metals (mg/kg)</b>								
Cadmium	0.36 – 4.3	2.0	33	33	100	8	0	39
Total mercury	0.2 U – 0.7	0.2	7	33	21	4	0	39
Zinc	35 – 224	120	33	33	100	9	0	39
<b>Phenols (Fg/kg)</b>								
Phenol	54 – 4,700	340	33	33	100	6	0	39
4-Methylphenol	180 – 78,000	3,300	33	33	100	6	0	39
<b>Dioxins and Furans (ng/kg)</b>								
2,3,7,8-Tetrachlorodibenzo-p-dioxin	0.6 U – 1.3 U	0.7	0	5	0	--	NA	NA
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	0.96 U – 1.6 U	1.4	0	5	0	--	NA	NA
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	1.0 – 1.5 <sup>b</sup>	1.3	4	5	80	D	NA	NA
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	2.0 – 4.7	3.7	5	5	100	D	NA	NA
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	1.6 U – 3.3	2.3	2	5	40	A	NA	NA
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	49 – 86	72	5	5	100	A	NA	NA
Octachlorodibenzo-p-dioxin	390 – 670	530	5	5	100	A	NA	NA
Total tetrachlorodibenzo-p-dioxins	17 – 61	46	5	5	100	B	NA	NA
Total pentachlorodibenzo-p-dioxins	4.4 – 21	14	5	5	100	D	NA	NA
Total hexachlorodibenzo-p-dioxins	17 – 44	35	5	5	100	D	NA	NA
Total heptachlorodibenzo-p-dioxins	120 – 190	180	5	5	100	A	NA	NA
2,3,7,8-Tetrachlorodibenzofuran	3.1 U – 4.7 U	4.3	0	5	0	--	NA	NA

**Table 11. (cont.)**

Analyte	Concentration Range	Median	Number of Detected Values	Number of Samples	Frequency of Detection (percent)	Station with Maximum Concentration	Interval of Maximum (in.)	
							Upper Depth	Lower Depth
1,2,3,7,8-Pentachlorodibenzofuran	0.66 – 0.89 <sup>b</sup>	0.9	2	5	40	B	NA	NA
2,3,4,7,8-Pentachlorodibenzofuran	0.87 U – 1.6	1.4	3	5	60	B	NA	NA
1,2,3,4,7,8-Hexachlorodibenzofuran	2.0 U – 6.7 U	4.7	0	5	0	--	NA	NA
1,2,3,6,7,8-Hexachlorodibenzofuran	0.88 – 1.9	1.9	4	5	80	B/C	NA	NA
1,2,3,7,8,9-Hexachlorodibenzofuran	0.63 U – 1.8 U	1.6	0	5	0	--	NA	NA
2,3,4,6,7,8-Hexachlorodibenzofuran	0.91 U – 2.1	1.5	3	5	60	A	NA	NA
1,2,3,4,6,7,8-Heptachlorodibenzofuran	14 – 29	18	5	5	100	A	NA	NA
1,2,3,4,7,8,9-Heptachlorodibenzofuran	0.82 U – 2.2	1.5	2	5	40	A	NA	NA
Octachlorodibenzofuran	30 – 46	39	5	5	100	C	NA	NA
Total tetrachlorodibenzofurans	7.7 – 23	20	5	5	100	A/D	NA	NA
Total pentachlorodibenzofurans	4.1 – 17	15	5	5	100	A	NA	NA
Total hexachlorodibenzofurans	14 – 39	27	5	5	100	A	NA	NA
Total heptachlorodibenzofurans	45 – 100	61	5	5	100	A	NA	NA
Dioxin and furan toxic equivalent concentration <sup>c</sup>	2.7 – 5.1	4.6	5	5	100	A	NA	NA
Dioxin and furan toxic equivalent concentration <sup>d</sup>	1.4 – 3.3	2.9	5	5	100	D	NA	NA

**Note:** Results are presented on a dry weight basis unless noted otherwise.

Concentrations for conventional analytes and organic compounds are rounded to two significant figures. Concentrations for metals are rounded to three significant figures if over 10 and two significant figures if less than 10.

Field replicates were treated as unique data points and the results were not averaged.

Medians were calculated using the detection limits for those congeners that were undetected.

-- - not applicable; the analyte was not detected at any station

NA - Not applicable. Because of the high analytical costs for dioxin and furan analyses, sediment samples were collected and composited across discrete horizons from two to four contiguous cores. Values reported represent results of analyses conducted on the composites.

PAH - polycyclic aromatic hydrocarbon

RPC - relative potency concentration

U - undetected at concentration listed

<sup>a</sup> When grain-size distribution is determined by the analytical laboratory, the term "gravel" is a designation for a specific size fraction in the sediment. This verbiage does not mean that the sediment is gravel. In some shallower parts of the Cove, the "gravel" size fraction could consist of wood debris and probably includes organic material.

<sup>b</sup> At least one detection limit exceeded the concentration of the indicated maximum detected value.

<sup>c</sup> Detection limits are included in the sum at half their value.

<sup>d</sup> Detection limits are excluded from the sum.

**Table 12. Comparison of native and non-native subsurface sediment data collected in Ward Cove in 1997**

Analyte	Native Sediment (4 samples)		Non-native Sediment (33 samples)	
	Concentration Range	Frequency of Detection (percent)	Concentration Range	Frequency of Detection (percent)
<b>Conventional Analytes</b>				
Total ammonia (mg/kg)	8.6 – 180	100	1.6 – 4,200	100
Biochemical oxygen demand 5-day test (g/kg)	0.2 U – 2.1	75	3.0 – 120	100
Chemical oxygen demand (g/kg)	0.2 – 5.4	100	1.3 – 140	100
Total sulfide (mg/kg)	3.3 – 770	100 <sup>a</sup>	290 – 55,000	100
Total organic carbon (percent)	0.36 – 12	100	10 – 40	100
Gravel (percent) <sup>b</sup>	0.1 – 37	100	0.5 – 61	100
Sand (percent)				
1.0 – 2.0 mm	0.3 – 6.6	100	1.3 – 13	100
0.50 – 1.0 mm	0.5 – 5.5	100	1.3 – 33	100
0.25 – 0.50 mm	2.7 – 8.3	100	2.7 – 37	100
0.125 – 0.25 mm	3.8 – 13	100	1.7 – 19	100
0.062 – 0.125 mm	9.5 – 19	100	1.2 – 24	100
Silt (percent)	16 – 69	100	4.8 – 61	100
Clay (percent)	6 – 30	100	8.9 – 37	100
Total solids (percent of wet weight)	23 – 68	100	11 – 30	100
<b>Metals (mg/kg)</b>				
Cadmium	0.11 – 3.4	100	0.36 – 4.3	100
Total mercury	0.2 U	0	0.2 U – 0.7	21
Zinc	56.8 – 96.3	100	35 – 220	100
<b>Phenols (Fg/kg)</b>				
Phenol	10 U – 150	75	54 – 4,700	100
4-Methylphenol	10 U – 350	50	180 – 78,000	100

**Note:** Results are presented on a dry weight basis unless noted otherwise.

Concentrations for conventional analytes and organic compounds are rounded to two significant figures.

Concentrations for metals are rounded to three significant figures if over 10 and two significant figures if less than 10.

U - undetected at concentration listed

<sup>a</sup> Only three native samples were analyzed for sulfide.

<sup>b</sup> When grain-size distribution is determined by the analytical laboratory, the term "gravel" is a designation for a specific size fraction in the sediment. This verbiage does not mean that the sediment is gravel. In some shallower parts of the Cove, the "gravel" size fraction could consist of wood debris and probably includes organic material.

**Table 13. Risk-based concentration algorithm for fish and shellfish consumption**

Risk-based concentration (carcinogenic effects) (mg/kg ww) =

$$\frac{TR \times AT_c \times BW}{CF \times EF \times ED \times FI \times IR \times CSF}$$

Risk-based concentration (noncarcinogenic effects) (mg/kg ww) =

$$\frac{THQ \times AT_n \times BW \times RfD}{CF \times EF \times ED \times FI \times IR}$$

where:

- TR = target risk (unitless)
- THQ = target hazard quotient (unitless)
- CF = conversion factor (kg/g)
- EF = exposure frequency (days/year)
- ED = exposure duration (years)
- FI = fraction ingested from contaminated source (unitless)
- IR = ingestion rate of fish/shellfish (g/day)
- BW = body weight (kg)
- AT = averaging time:
  - carcinogenic effects: 70 years × 365 days/year
  - noncarcinogenic effects: ED × 365 days/year
- CSF = carcinogenic slope factor (mg/kg-day)<sup>-1</sup> (chemical specific)
- RfD = reference dose (mg/kg-day) (chemical specific)

#### **Exposure Assumptions<sup>a</sup>**

Parameter		
TR	$1 \times 10^{-5}$ <sup>b</sup>	
THQ	1	
CF	$1 \times 10^{-3}$	
EF	350	
ED	30	
FI	0.05 <sup>c</sup>	
BW	70	
	<u>Fish</u>	<u>Shellfish</u>
IR <sup>d</sup>	65	11

<sup>a</sup> Algorithms and exposure assumptions from U.S. EPA (1989, 1991b), unless otherwise specified.

<sup>b</sup> Based on the draft ADEC (1998) guidance.

<sup>c</sup> Based on best professional judgment.

<sup>d</sup> Ingestion rates represent average seafood consumption rates for a subsistence community in the Ketchikan area.

**Table 14. Summary of results used to determine AET values for TOC<sup>a</sup>**

1996				1997			
Station	Concentration <sup>b</sup> (percent dry weight)	Amphipod Test	Echinoderm Test	Station	Concentration <sup>b</sup> (percent dry weight)	Amphipod Test	Echinoderm Test
5	36	X	X	5	38	X	X
6	33	X	X	38	34	X	X
1	32	X	X	2	33	X	X
16	31	X	X	37	31	X	-- <sup>d</sup>
17	31	-- <sup>c</sup>	X	3	30	X	X
26	30	--	--	35	30	--	X
9	27	X	X	34	29	X	X
10	27	--	X	16	28	--	X
4	26	X	X	17	28	X	X
7	26	--	X	47	26	X	X
14	25	X	X	44	26	X	X
15	25	X	X	7	26	X	X
8	24	X	X	48	25	X	X
12	24	X	X	4	25	X	X
3	22	--	X	42	24	X	X
13	22	X	X	39	23	X	--
21	21	--	--	40	23	--	--
27	21	--	--	32	23	X	X
28	20	X	X	13	22	X	X
19	18	X	--	41	22	--	X
20	17	X	--	31	21	X	X
2	14	X	X	12	21	X	X
11	14	--	X	45	21	X	X
23	13	--	X	27	20	--	X
24	13	--	X	11	19	--	X
25	11	X	X	28	19	X	X
22	5	--	--	43	18	X	X
18	1	--	X	19	17	X	X
				25	13	X	X
				23	9	--	--
				33	5	--	X
				18	4	--	X
				22	4	--	--

**Note:** AET - apparent effects threshold  
TOC - total organic carbon  
X - toxicity response was less than the sediment quality standard (SQS), indicating that an adverse effect was present  
-- - toxicity response was greater than the SQS, indicating that no adverse response was present

<sup>a</sup> Chemical concentrations are also presented in Tables 2 and 3 and toxicity responses and associated SQS comparisons are presented in Tables 6 and 7.

<sup>b</sup> Concentrations are listed in rank order.

<sup>c</sup> AET for the amphipod test.

<sup>d</sup> AET for the echinoderm test.

**Table 15. Summary of results used to determine AET values for total ammonia<sup>a</sup>**

1996				1997			
Station	Concentration <sup>b</sup> (mg/kg dry weight)	Amphipod Test	Echinoderm Test	Station	Concentration <sup>b</sup> (mg/kg dry weight)	Amphipod Test	Echinoderm Test
6	360	X	X	44	690	X	X
1	310	X	X	31	510	X	X
12	260	X	X	13	320	X	X
2	220	X	X	48	300	X	X
25	160	X	X	38	260	X	X
13	150	X	X	12	240	X	X
14	130	X	X	45	170	X	X
8	100	X	X	4	150	X	X
10	99	--	X	35	120	-- <sup>c</sup>	X
4	97	X	X	34	120	X	X
21	88	--	--	47	120	X	X
20	84	X	--	7	120	X	X
15	83	X	X	25	120	X	X
9	82	X	X	39	110	X	-- <sup>d</sup>
16	81	X	X	43	110	X	X
7	74	--	X	19	110	X	X
5	67	X	X	17	99	X	X
26	66	--	--	23	86	--	--
11	50	--	X	2	85	X	X
19	44	X	--	42	82	X	X
27	43	--	--	32	82	X	X
24	34	--	X	3	80	X	X
28	34	X	X	40	80	--	--
22	21	--	--	41	58	--	X
3	14	--	X	5	57	X	X
23	14	--	X	37	54	X	--
18	13	--	X	27	47	--	X
17	11	--	X	16	40	--	X
				11	34	--	X
				28	34	X	X
				33	23	--	X
				22	19	--	--
				18	13	--	X

**Note:** AET - apparent effects threshold  
 X - toxicity response was less than the sediment quality standard (SQS), indicating that an adverse effect was present  
 -- - toxicity response was greater than the SQS, indicating that no adverse response was present

<sup>a</sup> Chemical concentrations are also presented in Tables 2 and 3 and toxicity responses and associated SQS comparisons are presented in Tables 6 and 7.

<sup>b</sup> Concentrations are listed in rank order.

<sup>c</sup> AET for the amphipod test.

<sup>d</sup> AET for the echinoderm test.

**Table 16. Summary of results used to determine AET values for BOD<sup>a</sup>**

1996				1997			
Station	Concentration <sup>b</sup> (g/kg dry weight)	Amphipod Test	Echinoderm Test	Station	Concentration <sup>b</sup> (g/kg dry weight)	Amphipod Test	Echinoderm Test
9	19	X	X	38	65	X	X
16	18	X	X	4	64	X	X
1	16	X	X	3	46	X	X
14	16	X	X	2	45	X	X
6	13	X	X	23	37	-- <sup>c</sup>	-- <sup>d</sup>
4	12	X	X	25	34	X	X
8	12	X	X	27	34	--	X
20	11	X	-- <sup>e</sup>	28	32	X	X
5	10	X	X	11	14	--	X
12	10	X	X	35	14	--	X
27	10	--	--	16	13	--	X
28	10	X	X	44	13	X	X
2	9.9	X	X	13	12	X	X
10	9.8	--	X	31	11	X	X
19	9.6	X	--	34	10	X	X
25	9.2	X	X	17	10	X	X
7	8.7	--	X	48	9.2	X	X
26	8.5	--	--	5	9.2	X	X
13	8.3	X	X	32	9.1	X	X
23	7.9	--	X	45	9.1	X	X
17	7.6	--	X	19	8.5	X	X
3	7.3	--	X	7	8.0	X	X
24	7.0	--	X	40	7.8	--	--
11	6.4	--	X	39	7.7	X	--
21	6.2	--	--	43	7.4	X	X
15	6.0	X	X	47	7.1	X	X
22	3.5	--	--	37	7.1	X	--
18	1.4	--	X	42	6.9	X	X
				12	6.4	X	X
				41	6.4	--	X
				22	3.5	--	--
				33	1.7	--	X
				18	1.6	--	X

**Note:** AET - apparent effects threshold  
 BOD - biochemical oxygen demand  
 X - toxicity response was less than the sediment quality standard (SQS), indicating that an adverse effect was present  
 -- - toxicity response was greater than the SQS, indicating that no adverse response was present

<sup>a</sup> Chemical concentrations are also presented in Tables 2 and 3 and toxicity responses and associated SQS comparisons are presented in Tables 6 and 7.

<sup>b</sup> Concentrations are listed in rank order.

<sup>c</sup> AET for the amphipod test.

<sup>d</sup> This no-effect concentration was not used to set the AET because it is considered a chemical anomaly (i.e., it is more than three times greater than the next highest no-effect concentration).

<sup>e</sup> AET for the echinoderm test.

**Table 17. Summary of results used to determine AET values for COD<sup>a</sup>**

1996				1997			
Station	Concentration <sup>b</sup> (g/kg dry weight)	Amphipod Test	Echinoderm Test	Station	Concentration <sup>b</sup> (g/kg dry weight)	Amphipod Test	Echinoderm Test
8	2,400	X	X	41	52	--	X
7	620	-- <sup>c</sup>	X	25	30	X	X
16	620	X	X	23	26	--	--
5	590	X	X	48	19	X	X
9	550	X	X	16	16	--	X
26	550	--	-- <sup>d</sup>	11	16	--	X
6	540	X	X	44	15	X	X
12	520	X	X	38	15	X	X
15	490	X	X	31	13	X	X
1	480	X	X	4	13	X	X
4	470	X	X	45	12	X	X
13	440	X	X	34	12	X	X
21	420	--	--	2	12	X	X
10	340	--	X	27	12	--	X
2	330	X	X	19	11	X	X
27	330	--	--	42	11	X	X
28	330	X	X	40	11	--	--
19	270	X	--	35	10	--	X
3	250	--	X	3	10	X	X
23	200	--	X	43	10	X	X
11	190	--	X	17	10	X	X
14	190	X	X	7	10	X	X
24	190	--	X	37	8.7	X	--
25	160	X	X	39	8.3	X	--
17	150	--	X	47	7.9	X	X
20	120	X	--	12	7.8	X	X
22	98	--	--	32	7.1	X	X
18	17	--	X	13	7.0	X	X
				22	6.5	--	--
				5	5.6	X	X
				28	5.6	X	X
				33	4.5	--	X
				18	2.2	--	X

**Note:** AET - apparent effects threshold  
 COD - chemical oxygen demand  
 X - toxicity response was less than the sediment quality standard (SQS), indicating that an adverse effect was present  
 -- - toxicity response was greater than the SQS, indicating that no adverse response was present

<sup>a</sup> Chemical concentrations are also presented in Tables 2 and 3 and toxicity responses and associated SQS comparisons are presented in Tables 6 and 7.

<sup>b</sup> Concentrations are listed in rank order.

<sup>c</sup> AET for the amphipod test.

<sup>d</sup> AET for the echinoderm test.

**Table 18. Summary of results used to determine AET values for 4-methylphenol<sup>a</sup>**

1996				1997			
Station	Concentration <sup>b</sup> (µg/kg dry weight)	Amphipod Test	Echinoderm Test	Station	Concentration <sup>b</sup> (µg/kg dry weight)	Amphipod Test	Echinoderm Test
2	11,000	X	X	31	17,000	X	X
6	8,300	X	X	5	16,000	X	X
1	6,000	X	X	2	15,000	X	X
3	5,600	-- <sup>c</sup>	X	44	9,000	X	X
4	2,900	X	X	12	8,300	X	X
7	1,700	-- <sup>d</sup>	X	38	8,300	X	X
25	1,700	X	X	7	7,500	X	X
8	1,400	X	X	25	6,600	X	X
9	1,400	X	X	3	6,200	X	X
14	1,000	X	X	42	5,700	X	X
5	860	X	X	34	5,100	X	X
12	620	X	X	4	4,500	X	X
20	470	X	--	37	4,400	X	-- <sup>c</sup>
13	390	X	X	32	2,700	X	X
10	250 U	--	X	45	2,400	X	X
16	250 U	X	X	47	1,800	X	X
17	250 U	--	X	13	1,700	X	X
19	250 U	X	--	39	1,300	X	-- <sup>e</sup>
21	250 U	--	--	16	1,240	--	X
24	250 U	--	X	48	1,100	X	X
15	220	X	X	40	1,000	--	--
11	200 U	--	X	43	1,000	X	X
22	200 U	--	--	33	980	--	X
26	200 U	--	--	28	802	X	X
27	200 U	--	--	19	730	X	X
28	200 U	X	X	41	640	--	X
23	49	--	X	17	570	X	X
18	20 U	--	X	27	472	--	X
				35	460	--	X
				11	380	--	X
				23	168	--	--
				18	26	--	X
				22	24	--	--

**Note:** AET - apparent effects threshold  
X - toxicity response was less than the sediment quality standard (SQS), indicating that an adverse effect was present  
-- - toxicity response was greater than the SQS, indicating that no adverse response was present

<sup>a</sup> Chemical concentrations are also presented in Tables 2 and 3 and toxicity responses and associated SQS comparisons are presented in Tables 6 and 7.

<sup>b</sup> Concentrations are listed in rank order.

<sup>c</sup> This no-effect concentration was not used to set the AET because it is considered a chemical anomaly (i.e., it is more than three times greater than the next highest no-effect concentration).

<sup>d</sup> AET for the amphipod test.

<sup>e</sup> AET for the echinoderm test.

**Table 19. Cost estimates for remedial alternatives**

Alternative <sup>a</sup>	Estimated Capital Cost <sup>b</sup>	Estimated Operation and Maintenance Cost <sup>c</sup>	Estimated "In-water" Cleanup Time <sup>d</sup>	Estimated Time to Meet Remedial Action Objectives
A2	\$0	\$450,000	0 months	8 to more than 20 years
B Option 1	\$4,010,000 <sup>e</sup>	\$450,000	6 months	Active Remediation - less than 10 years
B Option 2	\$5,180,000 <sup>f</sup>			Natural Recovery - 8 to more than 20 years
C	\$16,440,000	\$450,000	Over 1 year	Same as Alternative B
D	\$32,300,000	\$450,000	Over 1 year	Same as Alternative B
E	\$29,280,000	\$450,000	Over 1 year	Same as Alternative B

<sup>a</sup> Alternatives as originally described in the RI/FS.

<sup>b</sup> Costs were based on thin-layer capping of 40 acres, and represent total present worth (1999). The accuracy of costs is estimated to be +50 percent to ! 30 percent.

<sup>c</sup> Estimated present net worth of 10 years of long-term monitoring costs.

<sup>d</sup> "In-water" refers to the time period that construction-related activities occur in the field (e.g., barges are placing capping material).

<sup>e</sup> Disposal of dredged material at Ketchikan Pulp Company landfill.

<sup>f</sup> Disposal of dredged material at Washington state landfill.

**Table 20. Cost estimate summary for the selected remedy**

<b>Construction Costs</b>			
<b>Item</b>	<b>Quantity</b>	<b>Unit Cost</b>	<b>Cost</b>
Placement of cap sand (21.3 acres)	17,200 cy	\$ 17.50	\$ 301,000
Placement of mound sand (6.0 acres)	24,200 cy	\$ 17.50	\$ 423,500
Delivery of sand to dockside	41,400 cy	\$ 25.00	\$ 1,035,000
Dredging/debris removal	20,550 cy	\$ 28.00	\$ 575,400
Placement in KPC Landfill	20,550 cy	\$ 16.00	\$ 328,800
Off-loading of logs	335 tons	\$ 60.00	\$ 20,100
Chipping of logs at KPC	335 tons	\$ 15.00	\$ 5,025
Mobilization/demobilization	1 lump sum	\$ 80,000.00	\$ 80,000
Field overhead	4 months	\$ 15,000.00	\$ 60,000
Water quality monitoring	85 days	\$ 1,500.00	\$ 127,500
Construction cost			\$ 2,956,325
Contingency	15 percent		\$ 443,449
<b>Construction Estimate</b>			\$ 3,399,774
Summary	Direct Costs	Percentage	Cost
Cap/mound 27.3 Acres	\$ 1,759,500	66	\$ 2,229,115
Dredge/disposal 20,550 cy	\$ 904,200	34	\$ 1,170,658
Sum	\$ 2,663,700.00	100	\$ 3,399,774
			Cap Unit Cost \$ 81,653 per acre
			Dredge/Upland Disposal Unit Cost \$ 56.97 per cy
<b>Non-Construction Costs</b>			
Design	7 percent of construction		\$ 237,984
Capping/dredging monitoring	85 days	\$ 2,430.00	\$ 206,550
Construction management	3.5 percent of construction		\$ 118,992
<b>Non-Construction Estimate</b>			\$ 563,526
<b>Total Estimated Capital Costs</b>			\$ 3,963,300
Periodic Monitoring Costs			
Monitoring every other year for 10 years	5 events	\$ 120,000.00	\$ 400,000
Present worth of 10 years monitoring			
<b>Total Estimated Costs</b>			\$ 4,363,300

**Note:** cy - cubic yard  
KPC - Ketchikan Pulp Company

Capital cost estimates are not discounted because the construction work is assumed to be performed in the first year. Monitoring costs are reported as present worth estimates given a 7 percent discount rate for a 10-year duration. Cost estimates are within +50 to ! 30 percent accuracy expectation.